Developing Standardized Low-Cost AC PV Systems

Highlights

- Designed and built a micro-inverter for a 240-W AC module; inverter is being manufactured, marketed, and sold
- Obtained UL listing and FCC certification for the micro-inverter
- Designed and built a 240-W DC module that has obtained a UL listing and that is being manufactured and marketed
- Designed and built complete home package systems based on line of amorphous silicon modules

Solar Design Associates, Inc., Solarex, and Advanced Energy Systems, Inc. participated in the 1995 solicitation of PVMaT—a cost-shared partnership between the U.S. Department of Energy and the nation's PV industry to improve the worldwide competitiveness of U.S. commercial PV manufacturing.

PVMaT Fact Sheet

Photovoltaic Manufacturing Technology

Solar Design Associates, Inc.

Goal

The goal of this contract under the 1995 PVMaT solicitation was to develop "building block" AC modules based on a large-area 240-W Solarex module. Each module would be complete with an inverter, usage reporting system, and mounting mechanism, and would be ready for direct connection to a building's AC wiring and to the utility grid. Specific objectives for Solar Design Associates (SDA) and its two prime subcontractors, Solarex and Advanced Energy Systems (AES), included the following:

- develop low-cost mounting systems for the AC modules (SDA, Solarex)
- develop an enhanced digital micro-inverter for the system (AES, SDA)
- develop innovative, low-cost wiring connection systems between modules and to building systems (Solarex, SDA)
- combine mounting and wiring systems with inverter and Solarex module in a standardized, modular package kit (Solarex, SDA)
- seek Underwriters Laboratories (UL) certification of module, inverter, and complete system (Solarex, SDA)
- develop Japanese and European versions of the inverter (AES, SDA)
- commercialize the complete system as a modular AC PV "building block" that can be mass produced and marketed (Solarex).

Background

Today, the PV industry offers a wide variety of commercial products. Yet, because PV modules generate DC electricity whereas homes and businesses run on AC electricity, most installations for AC use are essentially custom designed—with DC modules, special mounting structures for the modules, DC-to-AC inverters selected to match the system, and special wiring configured to match the AC needs of the building or the local utility. A standardized "AC module" that is ready to connect to the building and utility grid could greatly improve PV's marketability for utility interconnection.

SDA/PIX04472

A translucent, analog-inverter version of the AC module to be developed under this contract was installed in this entry canopy for the Natatorium at the 1996 Summer Olympics.

Technical Approach

AC modules developed under this project would have the potential to change the way utility-interactive PV systems are sized, priced, and installed. These modules could be marketed as complete packaged solutions for the emerging residential and commercial utility-inter-connected markets. There are several advantages of such modules:

- producing a single standard product could dramatically reduce manufacturing cost through mass production
- having a standard product simplifies installation, thus cutting costs
- the minimum system size of one AC module provides a low barrier to market entry
- the minimum increment size and elimination of balance-of-system equipment allows for maximum sizing flexibility and easy expansion

- there are no constraints on array orientation; individual modules could be aligned to fit the structure or to get more even generation throughout a day or year
- AC modules are inherently safer than high-voltage DC PV systems
- with two-way communications and data acquisition as standard features, AC modules are explicitly designed to be compatible with utility-interactive applications.

The Solarex 240-W module comes framed or as an unframed glass laminate. Unframed, it can be sold for direct building integration, where the module displaces conventional building materials such as architectural glass in commercial buildings. Putting this savings (in material and installation labor) toward the cost of the PV system makes PV more cost effective.

Results

This project was performed in two stages. In the first, all parties worked together to investigate mounting technologies and to develop and test the micro-inverter for the 240-W module. In the second stage, realizing that first-stage efforts were diverging, AES and Solarex concentrated on separate efforts—ones that were closer to the needs of the individual companies.

First Stage

SDA and Solarex investigated a variety of mounting technologies and selected three—one each for sloped roofs, flat roofs, and ground mounting—as being least expensive and most appropriate for the 240-W Solarex modules.

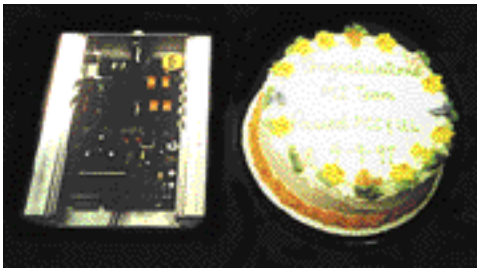
AES designed a digital micro-inverter based on SDA's analog micro-inverter developed under DOE's PV:BONUS Program.The new digital inverter was more reliable and less expensive than its analog counterpart, because it reduced the number of parts and the amount of circuit board required. Plus, it used a new aluminum case that also reduced costs while providing a professional appearance.

Solarex provided guidance by reviewing the performance of the inverter and by subjecting it to stringent environmental tests including thermal cycles and damp heat. Because the inverter would not meet the environmental tests without redesign—making it too costly for Solarex's commercial needs—the partners renegotiated the project to concentrate on separate efforts.

Second Stage

AES used the environmental tests and the UL requirements (including the suggestion that AC and DC wiring be placed in separate conduits) to redesign the inverter. The redesigned inverter won UL listing and FCC certification, assuring consumers that the product was safe and reliable and that it would not produce electromagnetic fields that interfered with electronic devices like cordless phones or computers. This new inverter was recognized by *Popular Science Magazine* as one of the 100 most significant products of 1998.

AES is manufacturing the inverter to be incorporated in modules developed and produced by other PV companies.



AES/PIX05938

The AES UL-listed and FCC-certified micro-inverter is no bigger than a birthday cake and easily fits on the back of a module.

Meanwhile, Solarex used the second stage of the project to finish developing its large-area (4 ft x 6 ft) 240-W module, which was also UL listed.This module uses low-cost framing, mounting, and wiring methods and may be easily integrated with an inverter for AC applications.

Solarex also took this opportunity to develop standardized home-package systems. These systems incorporate amorphous silicon modules and all the wiring and balance-of-system components required for easy integration into the typical utility-tied home. Today, Solarex is producing and marketing both its large-area DC module and its amorphous-silicon home systems.

Company Profile

Solar Design Associates

In 1974, Steven Strong founded Solar Design Associates to design energy-efficient buildings that would be powered by renewable energy.

Today, SDA has an international reputation for its pioneering and continuing efforts in integrating renewable energy systems with environmentally responsive building design. SDA now offers services that go beyond building design to embrace energy-systems engineering and technology development.

Solarex and AES

Solarex (now called BP Solarex), of Frederick, Maryland, is the largest U.S.-owned manufacturer of photovoltaics. Advanced Energy Systems, Inc. (now called Advanced Energy, Inc.), of Wilton, New Hampshire, designs and manufactures power electronics for the renewable energy industry. (For more in-depth profiles on these two companies, see the PVMaT fact sheets that describe other individual projects headed by the companies.)

References

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